The Examiner has objected to Figs. 6 and 7 and requested that they be designated as prior art. By the enclosed letter to the Chief Draftsperson submitted for the Examiner's approval, Applicant has designated Figs. 6 and 7 as prior art.

The Examiner has objected to claim 6 and pointed out a certain informality. In view of the amendment to claim 6, Applicant respectfully submits that the informality has been corrected.

The Examiner has rejected claims 1 and 3 under 35 USC 103 as being obvious over Connell in view of Bal et al., stating that Connell discloses an integrated piezoelectric oscillator with amplifier and resonator and integrated variable varactors and an AC voltage is developed on terminals A, B while a regulated control terminal 118 is connected to the other terminal, but the reference does not discuss an AC voltage with an intermediate voltage and does not specifically disclose a MOS type varactor; Bal et al. shows a waveform with an AC voltage and the fact that this reference makes explicit use of conventional MOS type capacitors; and it would have been obvious to one of ordinary skill in the art to modify Connell to provide a MOS type varactor in the oscillator as taught by Bal et al.

In reply to the rejection, Applicant would like to first point out that a variable-capacitance element is absolutely necessary for adjusting oscillation frequency in an oscillation circuit. In this regard, it has been well known to use an inverter amplifier in the circuit of a crystal oscillator. In such circuits, the capacitance value of varicap diode (variable-capacitance diode or Varactor diode; synonyms) D1 is changed in response to the direct current voltage that is applied to Vcont; as a result, it is possible to make a frequency adjustment by way of controlling the control voltage of the Vcont. On the other hand, in response to the recent demand for minituarization of various electronic appliances, it is necessary to minimize the size of oscillators, and this can be done by way of converting the oscillation circuit into an IC version. However, conversion of the circuits that include varicap diodes D1 into IC version is high in costs. Thus, in order to solve this problem, a MOS construction type capacitance element is proposed so as to be used as a variable-capacitance element that is suited to conversion into an IC (version).

Still further, Applicant respectfully submits that the MOS construction type capacitance element can vary its capacitance value over a wide range only with a use of a positive power supply and negative power supply. Thus, the problem is that almost no change in the

capacitance value occurs when it uses only either a positive or a negative (single-polarity) power supply. Furthermore, as is clear from the graph of Fig. 9 of Applicant's application that illustrates the relationship between the terminal-to-terminal voltage and the capacitance value of the MOS construction type capacitance element, when the terminal-to-terminal voltage varies within a range of from −1.5V to +0.5V including therein 0V therebetween, the capacitance value varies over a range covering approximately 80pF. However, in order to perform high-precision frequency control, it is preferable for the capacitance value to vary gently with respect to the changes in the control voltage than varies sharply. For this reason, there has been a demand for a variable-capacitance element in which its capacitance value varies over a wide range of control voltage. Nonetheless, in order to obtain a wide range of variable capacitance, control voltage sources that applies both positive and negative voltages to the control terminal Vcont is required. Therefore, the problem is that the structure of the system that performs the frequency control becomes complex.

In view of these prior art problems it is an object of the present invention to provide a small-sized piezoelectric oscillator which, while using a MOS construction type capacitance element that is suited to be converted into an IC (version) and of a two-terminal structure, can obtain a wide range of changes in the variable capacitance even with a use of only either positive or negative (single-polarity) power supply and which facilitates the frequency control.

More specifically, in Applicant's invention when, as shown in Figure 1, a direct current control voltage, whose level is from 0V to Vcc, is supplied to the control terminal Vcont, the terminal-to-terminal voltage of the MOS construction type capacitance element 3 varies within a range of from –Vcc/2 to +Vcc/2 with the potential at a point of connection between the control terminal Vcont and the input terminal of the inverter amplifier 1. Therefore, both a positive and a negative voltage are applied to the MOS construction type capacitance element 3, and the capacitance value thereof varies over a wide range. More specifically, when the inverter amplifier 1 operates with a power supply voltage Vcc = 5V, one terminal of the MOS construction type capacitance element 3 is applied with the threshold voltage Vref of the inverter amplifier 1, whose level is Vref = 2.5V. At this time, when a control voltage (Vcont) falling within a range of from 0V to 5V is supplied to the control terminal Vcont as a positive voltage, the terminal voltage Vcont–Vref of the MOS construction type capacitance element 3 is controlled within the range of from –2.5V to +2.5V. Accordingly, in Applicant's invention it

becomes possible to control the capacitance value over a wide range without using a negative power supply as in the prior art.

Furthermore, in Applicant's invention the MOS construction type capacitance element 3 is inserted in a loop of oscillation. Accordingly, to the terminal on the inverter amplifier 1 side of the MOS construction type capacitance element 3, an alternating current voltage, which is operating as an oscillation signal and the intermediate voltage thereof is the threshold voltage Vref whose level is Vref = 2.5v, is applied. Also, the amplitude level of the alternating current voltage has the characteristics that it affects the sensitivity to variable capacitance of the MOS construction type capacitance element 3. Accordingly, by way of positively utilizing this property, it is possible to suppress the sensitivity to variable capacitance of the MOS variable-capacitance element 3 to an arbitrary low value.

Accordingly, the present invention has a superior advantage that by way of controlling the terminal-to-terminal voltage of the MOS construction type capacitance element 3, a wide rage of capacitance variations is obtained, thus making it possible to perform the frequency adjustment easily.

With the above in mind, Applicant has carefully reviewed Connell and as seen from Fig. 1, this cited art is for a crystal oscillator in which Varactor diodes C1 and C2 are installed in the oscillation circuit so as to adjust the oscillation frequency. This in fact belongs to the prior art as described with reference to Figure 6, in the Prior Art section of Applicant's application. In other words, this prior art is absolutely silent about the features of the present invention that the variable-capacitance element is a MOS construction type capacitance element and that by way of applying an inverted bias to the MOS construction type capacitance element, the electric potential difference between the MOS construction type capacitance elements is inverted, thus making it possible to enlarge the width of the terminal-to-terminal voltage within one of polarity voltages and to widen the range of variable capacitance greatly, thus accomplishing the frequency adjustment.

Still further, in Fig. 2 of Connell, many more numbers of Varactor diodes are used, and MOS transistors (20A, 220B, 222A and 222B) are installed in the circuit. However, the MOS transistors are devices that function as a switch with a "binary: ON/OFF" function, and in its oscillation circuit, by way of the signals from the level shifters 224, the current to the Varactor diodes (214A, 214B, 216A, 216B) is turned ON and OFF, thus making the capacitance range

wider compared to the circuit of Fig. 1. The MOS construction type capacitance element of the present invention, however, does not function as a switch; and it always functions as a variable capacitance. Furthermore, in Connell, there is no disclosure or suggestion of the features of the present invention that the variable-capacitance element is a MOS construction type capacitance element and that by way of applying an inverted bias to the MOS construction type capacitance element, the electric potential difference between the MOS construction type capacitance elements is inverted, thus making it possible to enlarge the width of the terminal-to-terminal voltage within one of polarity voltages and to widen the range of variable capacitance greatly, thus accomplishing the frequency adjustment.

Applicant has carefully reviewed Bal et al. and respectfully submits that the MOS transistors 31 and 32 installed in the crystal oscillator do not function as a capacitance element but function as a variable resistance as is clear from the description at column 3, line 66 to column 4, lines 2, that reads, "There are also the resistances of the transistors 31 and 32 to consider. A resistance in series with a capacitor changes the effective capacitance. As the resistance goes up, the effective load capacitance goes down." As the resistance value of the N channel MOS transistor goes up by the control voltage V_{IN} outputted from the PRE-AMP 30, the effective capacitance formed by the condenser 31 (32) and N channel MOS transistors 33 (34) goes down, thus adjusting the oscillation frequency.

Furthermore, in Bal et al. the P channel MOS (41 to 43, 51 to 53) installed in the oscillation circuit are respectively controlled by the voltage from the input voltage V_{IN} (node 66), by the voltage from the node 67 that is between the N channel MOS transistors 61 and 62 and by the voltage from the node 68 that is between the N channel MOS transistor 62 and resistor 63, so that the respective P channel MOS's function as an ON/OFF switch. When they are ON, they function as a capacitance element of predetermined value; and by a combination of P channel MOS transistors which are ON, the capacitance is varied, thus adjusting the oscillation frequency.

Thus, it is clear that the oscillation circuits of Figs. 3 and 5 of Bal et al. do not disclose or suggest the features of the present invention that the variable-capacitance element is a MOS construction type capacitance element and that by way of applying an inverted bias to the MOS construction type capacitance element, the electric potential difference between the MOS construction type capacitance elements is inverted, thus making it possible to enlarge the width

of the terminal-to-terminal voltage within one of polarity voltages and to widen the range of variable capacitance greatly, thus accomplishing the frequency adjustment.

In view of the above, therefore, Applicant respectfully submits that not only is the combination suggested by the Examiner not Applicant's invention but also the combination suggested by the Examiner is not suggested by the art. Therefore, Applicant respectfully submits that claims 1 and 3 are not obvious over Connell in view of Bal et al.

Applicant acknowledges the Examiner's statement that claims 2, 4 and 5 are allowed.

Applicant further respectfully and retroactively requests a two-month extension of time so as to respond to the Office Action. Please charge Deposit Account No. 11-1445 in the amount of $400.00 as the fee.

Attached hereto is a marked-up version of the changes made to the specification, abstract and claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

In view of the above, therefore, it is respectfully requested that this Amendment be entered, favorably considered and the case passed to issue.

Please charge any additional costs incurred by or in order to implement this Amendment or required by any requests for extensions of time to KODA & ANDROLIA DEPOSIT ACCOUNT NO. 11-1445.

Respectfully submitted,

KODA & ANDROLIA

By: ____________________
William L. Androlia
Reg. No. 27,177

2029 Century Park East
Suite 3850
Los Angeles, CA 90067
Tel: (310) 277-1391
Fax: (310) 277-4118

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Washington D.C. 20231, on

July 18, 2002
Date of Deposit

William L. Androlia
Name

____________________ 7/18/2002
Signature Date

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Page 1, first full paragraph, has been amended as follows:

The present invention relates to a piezoelectric oscillator and, more particularly, to a piezoelectric oscillator that uses a MOS construction type capacitance element.

Page 3, third full paragraph, has been amended as follows:

On the other hand, as a variable-capacitance element suited to conversion to IC version, there is known a MOS [type variable-] construction type capacitance element, the utilization of that has been in expectation.

Page 3, fourth full paragraph, has been amended as follows:

As a crystal oscillator using such a MOS [type variable-] construction type capacitance element, there is the one that is disclosed, for example, in Japanese Patent Application Laid-Open No. 10-13155 entitled “Crystal Resonator with Frequency-Adjusting Function”.

The last paragraph bridging pages 3 and 4 has been amended as follows:

This crystal oscillator is constructed as follows. As illustrated in Fig. 7, between an input terminal and an output terminal of an inverter amplifier 101 there is inserted a parallel circuit comprised of a crystal resonator 102 and a feedback resistor R1. [A] Additionally, a capacitor C2 is connected to the output terminal of the inverter amplifier 101, and a MOS [type variable-] construction type capacitance element 103 is connected to the input terminal of the inverter amplifier. And, simultaneously, an electric-charge injection terminal TI of the MOS [type variable-] construction type capacitance element 103 and a control terminal Vcont are connected to each other.

Page 4, first full paragraph, has been amended as follows:

As the MOS [type variable-] construction type capacitance element 103, although it is only a mere one example, there is known the one illustrated in Fig. 8. Namely, in this element 103, a positive or negative voltage is applied to the control terminal Vcont by using the N type substrate as a basis to thereby cause the flow of a tunnel current through the interior of SiO_2 to thereby cause electrons to inject into or come out of a floating electrode 104.

The last paragraph bridging pages 4 and 5 has been amended as follows:

However, as will be explained below, fundamentally, the MOS [type variable-] construction type capacitance element can have its capacitance value varied over a wide range only with use of a positive power supply or negative power supply. For this reason, there was the drawback that almost no change in the capacitance value occurred when merely using only either a positive, or a negative, single-polarity power supply alone.

Page 5, second full paragraph, has been amended as follows:

Fig. 9 is a graph illustrating an example of the relationship between an inter-electrode voltage and a capacitance value of the MOS [type variable-] construction type capacitance element.

Page 5, fifth full paragraph, has been amended as follows:

Accordingly, in the case of the crystal oscillator such as that illustrated in Fig. 7, in order to obtain a wide range of variable capacitance with use of the MOS [type variable-] construction type capacitance element 103, it is necessary to use control voltage sources for applying both positive and negative voltages to the control terminal Vcont. Therefore, there was the problem that the construction of the system making control of the frequency became complex.

Page 6, first full paragraph, has been amended as follows:

The present invention has been made in order to solve the above-described problems and has an object to provide a small-sized piezoelectric oscillator which, while using a MOS construction type capacitance element suited to conversion to an IC version, enables obtaining a wide range of changes in the variable capacitance even with use of either a positive, or a negative, single-polarity power supply, and which facilitates the frequency control.

Page 6, second full paragraph, has been amended as follows:

To attain the above object, according to the first aspect of the invention, there is provided a piezoelectric oscillator wherein, in an oscillator including a piezoelectric resonator, an amplifier, and a variable-capacitance element, the variable-capacitance element is a MOS <u>construction</u> type capacitance element, one terminal of that is applied with an alternating current voltage, whose intermediate voltage is a V[-volt] voltage, and the other terminal of that is applied with a control voltage falling within a range whose intermediate value is the V[-volt] voltage.

The last paragraph bridging pages 7 and 8 has been amended as follows:

According to the second aspect of the invention, there is provided a piezoelectric oscillator wherein, in an inverter piezoelectric oscillator in which a piezoelectric resonator is connected between an input terminal and an output terminal of an inverter amplifier; and divisional capacitors C1 and C2 are connected between respective ends of the piezoelectric resonator and the ground, by inserting a MOS <u>construction</u> type capacitance element in series with the piezoelectric resonator, one end of the MOS <u>construction</u> type capacitance element is applied with a bias voltage which is the V[-volt] voltage at an output end or input end of the inverter amplifier and the other end thereof has supplied thereto a control voltage that varies within a range whose intermediate value is the V[-volt] voltage.

Page 7, first full paragraph, has been amended as follows:

According to the third aspect of the invention, there is provided a piezoelectric oscillator wherein, in an inverter piezoelectric oscillator in which a piezoelectric resonator is connected between an input terminal and an output terminal of an inverter amplifier; and divisional capacitors C1 and C2 are connected between respective ends of the piezoelectric resonator and the ground, two MOS <u>construction type</u> capacitance elements are inserted respectively on both sides of the piezoelectric resonator; one end of each of the MOS <u>construction type</u> capacitance elements is applied with an alternating current voltage, whose intermediate voltage is a V[-volt] voltage; and the other end thereof is applied with a control voltage that varies within a range whose intermediate value is the V[-volt] voltage.

The last paragraph bridging pages 7 and 8 has been amended as follows:

According to the fourth aspect of the invention, there is provided a piezoelectric oscillator wherein, in an inverter oscillator in which a piezoelectric element is connected to an input or output end of an inverter amplifier; and divisional capacitors C1 and C2 are connected between respective ends of the piezoelectric element and the ground, a MOS construction type capacitance element is inserted between the piezoelectric resonator and an input end of the inverter amplifier or between the piezoelectric resonator and an output end of the inverter amplifier; a control voltage Vcont is applied to the terminal on a connection-to-piezoelectric resonator side of the MOS construction type capacitance element; and, when it is assumed that V represents the voltage that is a direct current bias voltage at the input end or output end of the inverter amplifier and that is applied to one end of the MOS construction type capacitance element, it is arranged that said voltage becomes an intermediate voltage of the control voltage Vcont.

Page 8, first full paragraph, has been amended as follows:

According to the fifth aspect of the invention, there is provided a piezoelectric oscillator wherein, in an inverter oscillator in which a piezoelectric element is connected to an input or output end of an inverter amplifier; and divisional capacitors C1 and C2 are connected between respective ends of the piezoelectric element and the ground, a MOS construction type capacitance element is inserted between the piezoelectric resonator and an input end of the inverter amplifier or between the piezoelectric resonator and an output end of the inverter amplifier and a control voltage Vcont is applied to the terminal on the connection-to-piezoelectric resonator side of the MOS construction type capacitance element; a direct current circuit of a resistor and a capacitor is inserted and connected between the terminal on the inverter-amplifier side of the MOS construction type capacitance element and the input or output terminal of the inverter amplifier; and further a direct current bias voltage is applied to the terminal on the inverter-amplifier side of the MOS construction type capacitance element.

The last paragraph bridging pages 8 and 9 has been amended as follows:

According to the sixth aspect of the invention, there is provided a piezoelectric oscillator according to the fifth aspect of the invention, wherein the amplitude level of an alternating current supplied to the MOS construction type capacitance element is adjusted according to the value of the resistance of the direct current circuit; and when it is assumed that V represents the direct current bias voltage supplied to the terminal on the inverter-amplifier side of the MOS construction type capacitance element, it is arranged that the direct current bias voltage V becomes an intermediate voltage of the control voltage Vcont.

Page 10, fourth full paragraph, has been amended as follows:

Fig. 7 is a circuit diagram illustrating a conventional crystal oscillator using a MOS [type variable-] construction type capacitance element;

Page 10, fifth full paragraph, has been amended as follows:

Fig. 8 is a view of a sectional structure of the MOS [type variable-] construction type capacitance element; and

Page 10, sixth full paragraph, has been amended as follows:

Fig. 9 illustrates the relationship between a terminal-to-terminal voltage and a capacitance value of the MOS [type variable-] construction type capacitance element.

The last paragraph bridging pages 10 and 11 has been amended as follows:

The crystal oscillator illustrated in Fig. 1 has the following construction. Between input and output terminals of an inverter amplifier 1, whose power source voltage is Vcc, there are respectively inserted in parallel a feedback resistor R1 and a series circuit consisting of a crystal resonator 2 and a resistor R2. And, between the input terminal of the inverter amplifier 1 and the ground there is inserted a capacitor C1 while, on the other hand, between one end of the crystal resonator 2 and the ground there is inserted a capacitor C2. Further, between the other end of the crystal resonator 2 and the ground there is grounded via a capacitor C3 a MOS [type variable-] construction type capacitance element 3 while, on the other hand, a point of connection between the MOS [type variable-] construction type capacitance element 3 and the capacitor C3 is connected to a control terminal Vcont via a resistor R3.

Page 11, third full paragraph, has been amended as follows:

As apparent from the above-described explanation as well, the crystal oscillator illustrated in Fig. 1 is constructed in such a form wherein one terminal of the MOS [variable-] <u>construction type</u> capacitance element 3 is connected to the input terminal of the inverter amplifier 1. Therefore, as a result of this, to the other end of the MOS [variable-] <u>construction type</u> capacitance element 3 there is applied a voltage whose level is Vcc/2 that represents the threshold level voltage Vref of the inverter amplifier 1.

The last paragraph bridging pages 11 and 12 has been amended as follows:

And, in a case where having supplied a direct current control voltage, whose level is from 0V to Vcc, to the control terminal Vcont, the terminal-to-terminal voltage of the MOS [variable-] <u>construction type</u> capacitance element 3 varies within a range of from –Vcc/2 to Vcc/2 with the potential at a point of connection between the control terminal Vcont and the input terminal of the inverter amplifier 1 operating as a basis. Therefore, resultantly, both a positive and a negative voltage are applied to the MOS [variable-] <u>construction type</u> capacitance element 3 as was previously explained using Fig. 9, with the result that the capacitance value thereof varies over a wide range.

Page 12, first full paragraph, has been amended as follows:

Namely, for example, in a case where the inverter amplifier 1 operates with a power supply voltage Vcc=5V, the one terminal of the MOS [variable-] <u>construction type</u> capacitance element 3 is applied with the threshold voltage Vref of the inverter amplifier 1, whose level is Vref=2.5V. Further, at this time, when a control voltage (Vcont) falling within a range of from 0V to 5V is supplied to the control terminal Vcont as a positive voltage, the terminal voltage Vcont – Vref of the MOS [variable-] <u>construction type</u> capacitance element 3 is controlled within a range of from –2. 5V to +2.5V. Therefore, it is possible to control the value of the capacitance over a wide range without using a minus power supply as in the conventional example.

The last paragraph bridging pages 12 and 13 has been amended as follows:

Namely, in the above-described construction, the MOS [variable-] <u>construction type</u> capacitance element 3 is inserted into within a loop of oscillation. Therefore, to the terminal on

the inverter amplifier 1 side of it, there is applied an alternating current voltage, operating as an oscillation signal, the intermediate voltage of that is the threshold voltage Vref whose level is Vref=2.5v.

Page 13, first full paragraph, has been amended as follows:

And, there is the phenomenon that the amplitude level of the alternating current voltage affects the sensitivity to variable capacitance of the MOS [variable-] <u>construction type</u> capacitance element 3. By positively utilizing this property, it is possible to suppress the sensitivity to variable capacitance of the MOS [variable-] <u>construction type</u> capacitance element 3 to an arbitrary value.

Page 13, third full paragraph, has been amended as follows:

Here, for better understanding of the matter, it is assumed that the relationship between the terminal-to-terminal voltage and the capacitance value of the MOS [variable-] <u>construction type</u> capacitance element be set such that, as illustrated in Figs. 2(a) and 2(b), the capacitance value varies in response to a control-voltage range of from –0.5V to +0.5V with the intra-terminal voltage of 0V as the center.

The last paragraph bridging pages 13 and 14 has been amended as follows:

In Fig. 2(a), the solid line A illustrates the relationship between the intra-terminal voltage and the value of the intra-terminal capacitance that holds true when a direct current voltage Vref = 2.5V, equal in level to the threshold voltage, is applied to one terminal of the MOS [variable-] <u>construction type</u> capacitance element and a positive-polarity direct current control voltage about 2.5V as the center is applied to the other terminal of it. As seen, in a non-saturation region, in which the capacitance value linearly greatly varies, there is obtained a high sensitivity to variable capacitance of 80pF/V or so.

Page 14, first full paragraph, has been amended as follows:

Regarding such MOS [variable-] <u>construction type</u> capacitance element, under the assumption that the voltage Vref applied thereto be a bias voltage of 2.5V applied to the input terminal of the inverter amplifier 1, let's consider a case where that voltage Vref is an oscillation

alternating current voltage, which varies about the center voltage of 2.5V, and which is fed back to the input end of the inverter amplifier 1.

Page 15, first full paragraph, has been amended as follows:

On the other hand, when the amplitude level in the oscillation alternating current voltage is set to be an alternating current voltage C approximately equal to the width of the non-saturation voltage region as illustrated in Fig. 2(b), merely slightly decreasing the terminal-to-terminal voltage for example is followed by the arrival of the half cycles on the minus side of the alternating current voltage C at the saturation region. Therefore, the amount of change in capacitance that corresponds to the half cycles on the minus side in the region of the terminal-to-terminal voltage whose level is lower than that of such slightly decreased terminal-to-terminal voltage becomes small. Conversely, when making the level of the voltage Vcont higher than 0V, the MOS [type variable-] <u>construction type</u> capacitance element operates also similarly. Therefore, the capacitance sensitivity to terminal-to-terminal's voltage becomes wide in range as indicated in dotted line C', namely widely varies with respect to the terminal-to-terminal voltage. Resultantly, it is possible to make the variable-capacitance sensitivity to 40pF/V.

Page 16, third full paragraph, has been amended as follows:

The point at which the crystal oscillator illustrated in each of Figs. 3(a) and 3(b) differs from that illustrated in Fig. 1 is that the MOS [type variable-] <u>construction type</u> capacitance element 3 is inserted into between the crystal resonator 2 and the capacitor C1 or between the crystal resonator 2 and the capacitor C2. The circuit of Fig. 3(a) is constructed in such a form wherein one terminal of the MOS [type variable-] <u>construction type</u> capacitance element is connected to the output of the inverter amplifier 1 while the circuit of Fig. 3(b) is constructed in such a form wherein one terminal of the MOS [type variable-] <u>construction type</u> capacitance element is connected to the input of the inverter amplifier and the other terminal thereof is connected to the control terminal Vcont via a resistor R3.

The last paragraph bridging pages 16 and 17 has been amended as follows:

Further, if as illustrated in Fig. 3(a) a fixed resistor or variable resistor Rc is inserted into between the point E in the circuit and the ground whereby the value of this resistor Rc is made

arbitrarily settable, the voltage at the point E becomes controllable. As a result of this, the terminal-to-terminal's voltage of the MOS [type variable-] <u>construction type</u> capacitance element is controlled, which enables adjusting the frequency of the oscillation circuit.

Page 17, second full paragraph, has been amended as follows:

The respect in which the crystal oscillator illustrated in Fig. 4 differs from [that illustrated in Fig. 3] <u>those illustrated in Figs. 1, 3(a) and 3(b)</u> is that the MOS [type variable-] <u>construction type</u> capacitance element 4 is inserted into between the crystal resonator 2 and the capacitor C1 and the MOS [type variable-] <u>construction type</u> capacitance element 5 is inserted into between the crystal resonator 2 and the capacitor C2. It is thereby arranged that either one of such MOS [type variable-] <u>construction type</u> capacitance elements has its one terminal connected to either one of the input and output terminals of the inverter amplifier 1 and has its other terminal connected to the control terminal Vcont via a resistor R3 or R4.

The last paragraph bridging pages 17 and 18 has been amended as follows:

The respect in that the crystal oscillator illustrated in each of these figures is characterized is that the amplitude level of an alternating current voltage and a direct current bias voltage, which is a reference voltage, supplied to the MOS [type variable-] <u>construction type</u> capacitance element 3, are made respectively separately adjustable.

Page 18, first full paragraph, has been amended as follows:

Namely, the crystal oscillator is constructed as follows. As illustrated in each of those figures, the MOS [type variable-] <u>construction type</u> capacitance element 3 is inserted between the crystal resonator 2 and the capacitor C1 or between the crystal resonator 2 and the capacitor C2. A central point of connection between the crystal resonator 2 and the MOS [type variable-] <u>construction type</u> capacitance element 3 is connected to the control terminal Vcont via a resistor R3. Further, the other terminal of the MOS [type variable-] <u>construction type</u> capacitance element 3 is connected to a central point of connection in a series circuit of a resistor R5 and a resistor R6, which is connected between a power supply Vcc and the ground. On the other hand, said other terminal of the MOS [type variable-] <u>construction type</u> capacitance element 3, as illustrated in (a) of the figures, is connected to an output side of the inverter amplifier 1 and, as

illustrated in (b) of the figures, is connected to an input side of the inverter amplifier 1, via a series circuit of a resistor R2 and a capacitor C4.

The last paragraph bridging pages 18 and 19 has been amended as follows:

And, by constructing the circuit like that, initially, according to the relational expression of Vref (DC) = R6×Vcc / (R5 + R6), setting is performed of the reference voltage value Vref for the direct current bias voltage applied to the MOS [type variable-] construction type capacitance element 3 to thereby adjust the reference capacitance value of this element 3. Thereafter, according to the relational expression of Vref (AC) = R5×R6 ×V0 / {(R5 + R6)×(R2 + R5×R6 / (R5 + R6)}, adjustment is performed of only the resistance value alone of the resistor R2. Setting is thereby performed of the amplitude of the alternating current voltage supplied to the MOS [type variable-] construction type capacitance element 3. If thereby adjusting the sensitivity to capacitance of the MOS [type variable-] construction type capacitance element 3, this adjusting of the sensitivity to capacitance has no effect upon the set value of the reference capacitance. Resultantly, the process of adjusting the crystal oscillator is simplified.

Page 19, second full paragraph, has been amended as follows:

In the foregoing description, the present invention has been explained using the construction of applying the threshold voltage of the inverter amplifier 1 to one terminal of the MOS [type variable-] construction type capacitance element 3. However, the invention is not limited to such construction. But the invention may have a construction wherein a fixed voltage is applied to the one terminal of the MOS [type variable-] construction type capacitance element 3 with use of an external voltage or using a voltage that is produced using another voltage generation circuit, etc.

IN THE ABSTRACT:

The Abstract has been amended as follows:

A piezoelectric oscillator is disclosed which falls under the category of an oscillator including a piezoelectric resonator, an amplifier, and a variable-capacitance element. The variable-capacitance element is a MOS construction type capacitance element, one terminal of that is fixed at a V[-volt] voltage, and the other terminal of that is applied with a control voltage

falling within a range whose intermediate value is the V[-volt] voltage. As a result of this, a piezoelectric oscillator is realized which can vary its frequency over a wide range even without use of a minus power supply.

IN THE CLAIMS:

Claim 1 has been amended as follows:

1. (Amended) A piezoelectric oscillator, wherein, in an oscillator including a piezoelectric resonator, an amplifier, and a variable-capacitance element, the variable-capacitance element is a MOS construction type capacitance element, one terminal of [that] the MOS construction type capacitance element is applied with an alternating current voltage, whose intermediate voltage is a V[-volt] voltage, and the other terminal of [that] the MOS construction type capacitance element is applied with a control voltage falling within a range whose intermediate value is the V[-volt] voltage.

Claim 2 has been amended as follows:

2. (Amended) A piezoelectric oscillator, wherein, in an inverter piezoelectric oscillator in which a piezoelectric resonator is connected between an input terminal and an output terminal of an inverter amplifier; and divisional capacitors C1 and C2 are connected between respective ends of the piezoelectric resonator and the ground, and wherein by inserting a MOS construction type capacitance element in series with the piezoelectric resonator, one end of the MOS construction type capacitance element is applied with a bias voltage which is the V[-volt] voltage at an output end or input end of the inverter amplifier and the other end [thereof] of the MOS construction type capacitance element [has] is supplied [thereto] with a control voltage that varies within a range whose intermediate value is the V[-volt] voltage.

Claim 3 has been amended as follows:

3. (Amended) A piezoelectric oscillator, wherein, in an inverter piezoelectric oscillator in which a piezoelectric resonator is connected between an input terminal and an output terminal of an inverter amplifier; and divisional capacitors C1 and C2 are connected between respective ends of the piezoelectric resonator and the ground, and wherein two MOS construction type capacitance elements are inserted respectively on both sides of the

piezoelectric resonator; one end of each of the MOS construction type capacitance elements is applied with an alternating current voltage[,] whose intermediate voltage is a V[-volt] voltage; and the other end [thereof] of the MOS construction type capacitance element is applied with a control voltage that varies within a range whose intermediate value is the V[-volt] voltage.

Claim 4 has been amended as follows:

4. (Amended) A piezoelectric oscillator, wherein, in an inverter oscillator in which a piezoelectric element is connected to an input or output end of an inverter amplifier; and divisional capacitors C1 and C2 are connected between respective ends of the piezoelectric element and the ground, and wherein a MOS construction type capacitance element is inserted between the piezoelectric resonator and an input end of the inverter amplifier or between the piezoelectric resonator and an output end of the inverter amplifier; a control voltage Vcont is applied to the terminal on a connection-to-piezoelectric resonator side of the MOS construction type capacitance element; and, when it is assumed that V represents the voltage that is a direct current bias voltage at the input end or output end of the inverter amplifier and that is applied to one end of the MOS construction type capacitance element, it is arranged that said voltage becomes an intermediate voltage of the control voltage Vcont.

Claim 5 has been amended as follows:

5. (Amended) A piezoelectric oscillator, wherein, in an inverter oscillator in which a piezoelectric element is connected to an input or output end of an inverter amplifier; and divisional capacitors C1 and C2 are connected between respective ends of the piezoelectric element and the ground, and wherein a MOS construction type capacitance element is inserted between the piezoelectric resonator and an input end of the inverter amplifier or between the piezoelectric resonator and an output end of the inverter amplifier; a control voltage Vcont is applied to the terminal on the connection-to-piezoelectric resonator side of the MOS construction type capacitance element; and a direct current circuit of a resistor and a capacitor is inserted and connected between the terminal on the inverter-amplifier side of the MOS construction type capacitance element and the input or output terminal of the inverter amplifier; and further a direct current bias voltage is applied to the terminal on the inverter-amplifier side of the MOS construction type capacitance element.

Claim 6 has been amended as follows:

6. (Amended) A piezoelectric oscillator according to claim [6] 5, wherein the amplitude level of an alternating current supplied to the MOS construction type capacitance element is adjusted according to the value of the resistance of the direct current circuit; and when it is assumed that V represents the direct current bias voltage supplied to the terminal on the inverter-amplifier side of the MOS construction type capacitance element, it is arranged that the direct current bias voltage V becomes an intermediate voltage of the control voltage Vcont.